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Maurizio Carotenuto, Giovanni Libralato, Hatice Gürses, Antonietta Siciliano, Luigi Rizzo, Marco Guida, Giusy Lofrano. *Nonylphenol deca-ethoxylate removal from wastewater by UV/H2O2: Degradation kinetics and toxicity effects*. Pages 1-7.

Nonylphenol ethoxylated (NPEOs) nonionic surfactants have been increasingly used in different industrial, commercial and domestic applications. Unfortunately, they are classified as endocrine disrupting chemicals (and also considered as contaminants of emerging concern) having adverse effects on animal and human reproduction. The treatment of nonylphenol-decaethoxylated (NP-10) via H2O2/UV-C process at different reaction times (5, 10, 20, 40, 80 min) and H2O2 concentrations was investigated. After 80 min treatment the removal rates of NP-10 solution (initial concentration 100 mg/L) in deionized water were 88%, 97% and 98% for 10, 20 and 100 mg/L of H2O2 respectively. The same experimental conditions were applied to real wastewater spiked with 100 mg/L of NP-10 showing the following removal rates: 84%, 98% and 99%, respectively. The possible contribution of different radicals to NP-10 degradation by H2O2/UV-C treatment was investigated by evaluating the effect of different radical scavengers (namely NO3−, NaCl, Na2SO4, Na2CO3, KH2PO4 and phatalate). Toxicity data (Aliivibrio fischeri, Raphidocelis subcapitata and Daphnia magna) on treated solutions and wastewater highlighted the presence of residual toxicity in all samples evidencing that no complete mineralization occurred.

- **Keywords:** Nonylphenol ethoxylates; Wastewater; Advanced oxidation processes; Radical scavengers; Ecotoxicology

Muhammad Bilal, Hafiz M.N. Iqbal. *Microbial-derived biosensors for monitoring environmental contaminants: Recent advances and future outlook*. Pages 8-17.

Living cells have evolved to sense various environmental stimuli, thus presenting a novel platform to engineer bio-sensing devices. Owing to the ease of genetic modification and preservation, microorganisms have gained a special place as ideal host candidates. Moreover, microbial-derived biosensors are easy to use, inexpensive, compact, and portable. The unique structural and functional features rendering them exceptionally suitable for detection and monitoring of an array of environmentally-related pollutants. The manipulation of regulatory genes could upgrade a range of characteristic features of a biosensor such as sensitivity, selectivity and, target range. Contemporary uses of such genetically-microbe-based biosensors led to the fabrication of biosensors with

unprecedented potentialities for monitoring environmental pollution. Herein, we reviewed the current advances in microbial-derived biosensors for monitoring environmentally-related contaminants. A particular emphasis is given to the improvement of genetically-engineered microbial biosensors and their application for environmental pollutants monitoring with up-to-date examples. Critical challenges including technical and societal are also highlighted to decipher the true perspective of microbial-derived biosensors for their widespread adoption and exploitation. Towards the end, the work is wrapped up with concluding remarks and future viewpoints to highlight the value of the microbial-derived biosensors, which could detect various pollutants or toxic compounds from a broader spectrum in the real-time, rapid and unique way with high sensitivity, and outstanding selectivity.

- **Keywords:** Microbial-derived biosensor; Genetically engineered microbes; Environmental monitoring; Contaminants; Regulatory genes; Reporter genes

Paul Swuste, Karolien van Nunen, Genserik Reniers, Nima Khakzad. *Domino effects in chemical factories and clusters: An historical perspective and discussion*. Pages 18-30.

Major accidents in Western countries, receiving a lot of media attention in the 1970s, are starting point for research into internal and external domino effects in the chemical and petrochemical sectors and clusters. Initially, these reports are published by government institutions and government-related research centres. With the upcoming quantitative risk analyses in the 1970s and 1980s, the so-called öcoloured books', published in the Netherlands, play a prominent role in quantifying these domino effects. Since the mid 1990s, the second European Seveso Directive encourages scientific research on domino effects, shown in substantially growth of academic publications on the topic. Research in Western countries is dominated by risk assessments, probabilities, and failure mechanisms are calculated for the complex phenomenon of domino effects and its consequences. Previous works are closely related to political, official and private decision-making. A transition towards risk management is still in its infancy. A future transition is necessary to understand initial scenarios as starting points for domino effects. In India a wake-up call for domino effects occurs in the mid-1990s. Chinese publications on domino effects in the international scientific press appear from the mid-2000s onwards. Due to a rapid industrialisation, the numbers in China country are overwhelming, versus chemical companies, as versus of many major accidents in this sector. This article will discuss results of research on domino effects, conducted in the period 1966–2018, as well as major determinants of these accident processes. Also present, and future transition in this research domain will be discussed.

- **Keywords:** Domino-effects; Process industry; Chemical cluster; History; Review

Mostafa M. Hamed, Reham S. Hassan, Sayed S. Metwally. *Retardation behavior of alum industrial waste for cationic and anionic radionuclides*. Pages 31-38.

For long-term performance evaluation of radioactive waste repositories, knowledge about the radionuclides adsorption by backfill materials is required. As a part of the multi-barrier system for effective isolation of radioactive waste in a repository, alum industrial waste was evaluated to be utilized as a backfill material. In this concern, the adsorption behavior of 137Cs, 90Sr and 131I (as a surrogate for 129I) radionuclides on alum industrial waste (AIW) was investigated to simulate the optimum conditions under which AIW can be used as an adsorbent employing batch method using radiotracer technique. AIW was characterized using SEM, FT-IR, XRD, XRF and TGA & DTA. AIW has been successfully applied for the adsorption of some radionuclides from real radioactive waste. The results indicated that more than 90% of these radionuclides were efficiently retained onto AIW. Based on the results, it can be concluded that the AIW is an economic and

efficient retaining material for environmental hazardous migration and/or leakage of some radionuclides such as 131I, 137Cs, 90Sr, 60Co, 212Pb and 152+154Eu. Therefore, this study could be used as a starting point to establish and consider AIW as a backfill material in the radioactive waste disposal process.

- **Keywords:** Backfill material; 137Cs; 90Sr; 131I; Adsorption; Radioactive waste

Deepshikha Datta, Gopinath Halder. *Effect of media on degradability, physico-mechanical and optical properties of synthesized polyolefinic and PLA film in comparison with casted potato/corn starch biofilm*. Pages 39-62.

The present work focuses the degradation rate of compression moulded Low Density Polyethylene (LDPE), High Molecular Weight High Density Polyethylene (HMHDPE), Linear Low Density Polyethylene (LLDPE) and PLA (Poly lactic acid) films in comparison with solvent casted starch (corn and potato) films under different media. The control film (0 week) and degraded films were subjected to various physical and thermal test (density, crystallinity, tensile, melt flow index, Young's modulus, elongation) and biodegradation quantification (mass loss, swelling index, haze, transmittance, gloss). The microstructure revealed that potato starch film containing lower amylose content (21%) and 2 ml (32 wt% of starch dry basis) glycerol (plasticizer) produced transparent, uniform, thin (117 μm) films with higher tensile (3.16 MPa) and good surface gloss at 45° (17.4%) whereas corn starch films (water solubility - 40.26%) has a higher biodegradability rate in all the media (94.23% in vegetable waste and 99.99% in 0.1 N HCl) can act as a better biofiller. The highest degradation was observed in soil in which LDPE showed the maximum weight loss (0.974%) and drop in tensile load at break (30.176 N to 14.93 N) and HMHDPE showed the minimum value of 0.868% and 44.67 N to 40.24 N respectively in one year.

- **Keywords:** Degradation; Compression moulding; Plasticizer; Swelling index; Gloss

Lihong Han, Ming Liu, Sheji Luo, Tian Jian Lu. *Fatigue and corrosion fatigue behaviors of G105 and S135 high−strength drill pipe steels in air and H2S environment*. Pages 63-74.

Fatigue and corrosion fatigue (CF) tests were carried out to investigate the behaviors of G105 and S135 low carbon high−strength drill pipe steels under different stress amplitudes in air as well as simulated H2S contained drilling environment. The regression analysis method was applied to obtain empirical equations governing the fatigue and CF lives of drill pipe steels in different environmental conditions. Results revealed that there exist fatigue limits for G105 and S135 drill pipe steels in air, and the fatigue life equations for G105 and S135 are Nf=3.28×108(Seqv−406.1)−2 and Nf=3.81×108(Seqv−472.5)−2 respectively. For both types of pipe steels, quasi−cleavage and cleavage fracture was identified as the main feature in the fatigue source zone of the two steels, while fatigue striations were the main feature in the stable crack growth zone. However, in H2S solution, no obvious fatigue limits were found for G105 and S135, and the corresponding CF life equations are Nf=3.58×108(Seqv−143.7)−2 and Nf=2.91×108(Seqv−119.6)−2. The CF sensitivity levels of G105 and S135 in H2S solution are high (64.6% and 74.7%, respectively), but S135 displays a higher sensitivity (74.7%) than G105 (64.6%). Further, no apparent plastic deformation appeared on the fracture surface in H2S solution, and the fatigue cracks sprout from the surface and expand into the specimen with radiation pattern.

- **Keywords:** Drill pipe steel; Hydrogen sulfide; Corrosion fatigue; Elastic fracture mechanics

Wan-li Xiong, Juan Zhang, Jun-xia Yu, Ru-an Chi. *Competitive adsorption behavior and mechanism for Pb2+ selective removal from aqueous solution on phosphoric acid modified sugarcane bagasse fixed-bed column*. Pages 75-83.

Competitive adsorption behavior and mechanism for Pb2+ selective removal from aqueous solution on phosphoric acid modified sugarcane bagasse (PA-SCB) were investigated in Pb/Cu, Pb/Zn, Pb/Cd and Pb/Ca binary system under dynamic condition. Results verified by EDX analysis showed that Pb2+ with the highest adsorption affinity substituted the adsorbed co-ions during the adsorption process, and amount of Cu2+, Zn2+, Cd2+ and Ca2+ desorbed was 5.5, 6.3, 13.7 and 6.2 mg g−1, respectively. Desorption and release of the adsorbed co-ions into the solution resulted in an obvious overshoot peak in their breakthrough curves, which could be predicted well by Chromatographic Gaussian equation. Selective adsorption of Pb2+ was further verified in Pb/Cu/Zn/Cd/Ca/Mg system, and amount of Pb2+ adsorbed on the column was respective 24.5-, 13.6-, 12.8-, 91.1- and 159.5- times of Cu2+, Zn2+, Cd2+, Ca2+ and Mg2+. Wastewater treatment experiment showed that the amount of Pb2+ adsorbed on the column was 73.7 mg g−1, while that of Cu2+, Cd2+, Zn2+, Ca2+ and Mg2+ was 4.4, 0.4, 0.3, 0.2 and 0.03 mg g−1, demonstrating that Pb2+ could be absorbed efficiently from the complex system. The as prepared column had great potential in Pb2+ selective removal form practical waste water.

- **Keywords:** Sugarcane bagasse; Phosphoric acid; Pb2+; Competitive substitution; Adsorption

Yunpei Liang, Jiahui Dai, Quanle Zou, Lei Li, Yongjiang Luo. *Ignition mechanism of gas in goaf induced by the caving and friction of sandstone roof containing pyrite*. Pages 84-96.

With the extensive application of fully mechanized top coal caving technology with a large mining height, a comprehensive investigation of the ignition mechanism of gas in a goaf induced by the caving of hard and thick sandstone roofs is of great importance. In this paper, the mineral compositions of the roofs of the coal seams in the working face were analyzed, the motion modes during the caving of hard roofs were investigated, and the friction force was calculated. Besides, the generation law of sparks induced by the friction of different rock combinations, the distribution law of gas in the goaf, and the flammable and potential explosive zones were investigated and determined. The research results indicate that the range of impact velocity and friction force induced by a roof caving are large under different roof caving modes. The spark generated by interactive friction during the caving of rocks is an important ignition source, and the presence of pyrite can significantly improve the temperature of the contact surface, thereby increasing the intensity of the sparks. In the flammable and explosive zone, gas combustion or explosion is likely to be triggered when high-temperature sparks are generated by an impact occurring during the caving of the hard roof. The results derived can provide an important theoretical basis for the safe and efficient production of coal mines under the similar conditions of Xinji No.2 Coal Mine.

- **Keywords:** Hard roof; Pyrite; Impact and friction; Ignition mechanism

Julio A. de Lira-Flores, Antioco López-Molina, Claudia Gutiérrez-Antonio, Richart Vázquez-Román. *Optimal plant layout considering the safety instrumented system design for hazardous equipment*. Pages 97-120

The safety of the process plant depends on the adequate separation between the assets and the hazardous units, along with the installation of protection devices. Several mathematical approaches have been proposed to reduce the risk of the explosions

through the solution of the facility layout problem, but no model has included the design of the safety instrument systems. In this work, a MINLP approach was developed to solve three issues at the same time: the process equipment layout, the facility layout, and the safety instrumented system design. This approach aims to find the optimal facility layout that minimizes the land cost, the pipeline cost, and the lifecycle cost of each safety instrumented system, reducing the risk of explosions and keeping safety as much as possible the plant assets. The model was applied to find the optimal facility layout of ethylene oxide plant for different tolerable risk frequencies. In this way, this approach provides valuable information during the design stage and substantial support for decision-makers.

- **Keywords:** Plant layout; Safety instrumented system; Optimization; Domino effect; Probability of failure on demand

M.A. Sedghamiz, F. Attar, S. Raeissi. *Experimental investigation of acid regeneration of spent bleaching clay de-oiled by the in-situ transesterification process at various operating conditions*. Pages 121-127.

The spent bleaching clay (SBC) from the edible oil refining industries contains different types of contaminants, including fatty acids and trace amounts of heavy metals and hazardous materials. Therefore, the conventional procedure of landfilling of SBC is not safe for the environment. Because of this, researchers have been trying to find alternative routes, such as novel processes to regenerate the clay and reuse it. The large amounts of oil remaining in SBC justifies the investigation of in-situ transesterification of the oil to biodiesel. In this study, clays that have been de-oiled by in-situ transesterification at various operating conditions are investigated for their final regenerated bleaching capacity. The different in-situ operating parameters considered are: the choice between two different alkali catalysts, catalyst/SBC ratio, ethanol/SBC ratio, temperature, and reaction time. With 60 different experiments and using the method of experimental design, the optimum operating parameters were determined and presented for achieving maximum bleaching capacity of the regenerated clay. The suggested conditions were then confirmed experimentally. Results showed that the maximum bleaching capacity at these optimum conditions was 17.03%.

- **Keywords:** Spent bleaching clay; Acid activating; Regeneration; In-situ esterification; Bleaching capacity

Nedra Asses, Walid Farhat, Moktar Hamdi, Hassib Bouallagui. *Large scale composting of poultry slaughterhouse processing waste: Microbial removal and agricultural biofertilizer application*. Pages 128-136.

This work investigated the potential of composting treatment for hygienization and material recycling from poultry slaughtering by-products and wastes in the context of management aspects and the agricultural value of the final product. A large scale composting cycle of 300 m3 was performed for 90 days, in which poultry slaughterhouse waste (59.65%) was mixed with sewage sludge (4.83%), agricultural waste, cardboard (4.83%), and wood dust (19.35%) and activated compost (11.29%). During the composting progress, physical chemical parameters, FTIR analysis and biological indicators reflecting stability of the compost were analysed for the assessment of the product quality. The composted mixture showed a high microbial activity with a succession of microbial populations depending on the temperature reached during different degradation phases. The thermophilic phase lasted 20 days with temperature exceeding 65 °C allowing pathogens reduction. Fecal coliforms, Streptococci and Escherichia coli were reduced and remained less than values recommended by international guideline. Whilst Salmonella has disappeared at the end of the process. The

Composting poultry slaughterhouse waste allowed obtaining hygienic compost with sufficient agronomic quality characterized by a relatively high organic matter content (49.12%), a C/N ratio (13.92%), an alkaline pH (7.7) and a high level of nutrients. The germination indexes reached 91% in the end of process that proved to be good maturity indicators. The compost application in peat amended at ratios equal to 8 t.ha−1, improved the growth of stem length (63.8%), leaf length (57.9%), fresh biomass (65.1%) and dry biomass (66.6%) of maize plants showing that the final slaughterhouse compost presented high level of maturity and it was not phytotoxic.

- **Keywords:** Composting; Slaughterhouse waste; Hygienization; Phytotoxicity; Agricultural bioassay

Tadashi Nittami, Tadashi Shoji, Yusuke Koshiba, Mana Noguchi, Mamoru Oshiki, Masashi Kuroda, Tomonori Kindaichi, Junji Fukuda, Futoshi Kurisu. *Investigation of prospective factors that control Kouleothrix (Type 1851) filamentous bacterial abundance and their correlation with sludge settleability in full-scale wastewater treatment plants*. Pages 137-142.

Kouleothrix (Type 1851) filamentous bacteria associated with bulking incidents were investigated for their quantitative correlations with sludge settleability in municipal wastewater treatment plants (WWTPs) around Japan. Factors affecting their abundance were also explored by statistical analyses with the aim of controlling bulking by suppressing their growth. Real-time quantitative PCR assays showed Kouleothrix spp. mainly ranged from 104−105 copies ng-DNA−1 in WWTPs. They were not always abundant in every WWTP, but their abundance (>105 copies ng-DNA−1) almost always coincided with low activated sludge settleability. Their abundance in nitrogen removal processes was always low (1.08 − 3.83 × 104 copies ng-DNA−1). Denitrification process at the feeding stage may be a useful selection pressure for Kouleothrix spp., leading to their suppression. A stepwise multiple regression analysis revealed that the increase of dissolved oxygen (DO) and pH in an aeration tank have a negative influence, while NH4+ increase in the influent has a positive influence on the Kouleothrix spp. abundance. The three-variable model was significant and accounted for approximately 45% of the variance in the dependent variable (i.e., Kouleothrix spp.). The DO increase had the greatest influence on the Kouleothrix spp. decrease, and thus, the DO control may be a promising way to suppress their growth in WWTPs.

- **Keywords:** Kouleothrix (Type 1851) filamentous bacteria; Real-time qPCR; Sludge volume index (SVI); Multiple regression analysis; Activated sludge bulking; Wastewater treatment plant (WWTP)

Yibo Tang, Huae Wang. *Experimental investigation on microstructure evolution and spontaneous combustion properties of secondary oxidation of lignite*. Pages 143-150.

Effective prevention and control of spontaneous fire of low-rank coal at underground goafs are critical to ensure coal mine safety. The characteristics of secondary oxidation of two lignites types were investigated. The results show that the spontaneous combustion tendency of the preoxidized lignite is higher than that of the raw coal, especially in the early stages of low-temperature oxidation. After preoxidized by air under different conditions, coal samples were used in an adiabatic oxidation experiment (by H2O2) to simulate the self-heating process. The experimental results show that after being pre-oxidized 100–150 °C, the oxidation rate of coal sample re-oxidation increased significantly. and this effect is closely correlated to the treatment time and temperature. The TG/DSC tests show that preoxidation gradually increases the self-heating risk of coal; however, when the treated temperature exceeds 175°C, the calorific value of coal

decreases sharply. The preoxidation step weakens some functional groups in coal to a certain degree, but the proportion of CO structure fluctuates, decreasing the activation energy of the secondary oxidation of coal between 40 and 120 °C. The proportion of coal particles with porosity >10 nm increases in coal samples studied after the treatment, which favors the oxidation diffusion of coal. In general, secondary oxidation causes microstructural changes in lignite and increases the risk of spontaneous combustion, but preoxidation at an excessively high temperature may over consume the organic constituents, decreasing the liability of self-heating.

- **Keywords:** Spontaneous combustion; Lignite; Secondary oxidation; Coal mine safety

L.R. López, M. Mora, J.A. Baeza, J. Lafuente, D. Gabriel. *Titrimetry as a tool for the on-line monitoring of biological activity in a desulfurizing biotrickling filter under aerobic conditions*. Pages 151-157.

Titrimetry is a well-established technique that has not been previously used in bioreactors for waste gas treatment. This work explored the information behind titrimetric data such as the proton production (HP) and the proton production rate (HPR) to evaluate their suitability for the on-line monitoring of the biological activity of an aerobic biotrickling filter (BTF) targeting the removal of high concentrations of H2S. The different contributions to the titration rate in the bioreactor were identified and quantified to further calculate the biological HP and HPR due to biological sulfide oxidation. Variable H2S concentrations ranging from 2000 to 10,000 ppmv were treated in a lab-scale biotrickling filter mimicking the conditions typically found during biogas desulfurization. Results indicated that the biological HP and HPR are suitable variables for process monitoring since both provided a good correlation between operational conditions and biological activity at inlet H2S concentrations above 4000 ppmv. The different dynamics of the liquid and the gas phases in BTFs were identified as the main factors influencing the potential use of on-line titrimetry in desulfurizing BTFs. Titrimetric variables did not correlated well with H2S measurements. Instead, titrimetry allowed determining the biological activity leading to key operational changes such as the breakthrough point in which the BTF mainly produced elemental sulfur, a solid that handicaps BTFs operation in the long run due to its accumulation in the packed bed. Titrimetric variables monitoring enhanced the understanding of biological processes occurring in the BTF denoting a great potential to be included as a complementary monitoring tool in the operation of full-scale BTFs for biogas desulfurization.

- **Keywords:** Biotrickling filter; Hydrogen sulfide; On-line monitoring; Titrimetry; Proton production; Biological activity

Abbass Jafari Kang, Giulio Munz, Qiuyan Yuan. *Influence of pH control on material characteristics, bacterial community composition and BNR performance of mature aerobic granules*. Pages 158-166.

The influence of different pH conditions on the characteristics, nutrient removal efficiency and bacterial community structure of mature granules. Three identical sequencing batch reactors with stable granules were operated under controlled pH (≤7.0 and ≤7.5) and uncontrolled pH (initial pH = 7.5) conditions for two months. Results show that pH ≤ 7.0 significantly affected properties of the granules. Extracellular polymeric substance content decreased from 134 to 101 mg/gVSS, granules' size decreased from 660 to 449 μm, and fraction of floccular biomass increased from 7.8 to 26.3%. However, maintaining pH ≤ 7.5 did not show significant impact on these parameters. Moreover, pH ≤ 7.0 deteriorated nitrogen removal (from 44.4 to 17.7%) by depleting the alkalinity and inhibiting the activity of nitrifying bacteria. Phosphorus removal was also significantly influenced by the pH control such that pH ≥ 7.5 improved the phosphorus removal from 90.8 to 99.6%, while pH ≤ 7.0 obtained 63.1% phosphorus removal. Results of DNA

sequencing showed that pH control influenced bacterial community structure of the granules. The results confirmed the increase in the abundance of Dechloromonas, which were the main polyphosphate accumulating organisms at pH ≤ 7.5. Our results suggest that pH adjustment could alter bacterial communities of mature granules and therefore could be used to improve treatment functionality of the granules.

- **Keywords:** Aerobic granules; pH control; Biological nutrient removal; Wastewater treatment; Bacterial community composition

M.A. Semin, L.Yu. Levin. *Stability of air flows in mine ventilation networks*. Pages 167-171.

This paper presents an algorithm for calculating the stability of air flows in mine ventilation networks in case of random variations of air resistance. The analysis of the stability of air flows in the algorithm is based on two proposed criteria, which are calculated for each branch of mine ventilation network: the guaranteed minimum air flow and the relative deviation of the air flow. The algorithm calculates the distribution of both criteria in the mine ventilation network and allows detecting sections of the mine ventilation network with the least stable air flows. This information can be used to develop different measures to improve the stability of air flows in these sections, which is necessary to ensure the safety of mining operations. The advantages of the proposed algorithm are high calculating speed and intelligibility of the criteria for evaluating the airflow stability in each airway. The convergence of the algorithm is also studied in this paper for a set of ventilation networks. The results of numerical calculation of air flow stability for the undermining level of the Taimyrsky mine are presented.

- **Keywords:** Mine ventilation; Stability of air flows; Numerical simulation; Occupational safety

M. Concetta Tomei, Domenica Mosca Angelucci. *Enhancing biodegradation of toxic industrial wastewaters in a continuous two-phase partitioning bioreactor operated with effluent recycle*. Pages 172-180.

In this study, we propose the application of a Continuous Two-Phase Partitioning Bioreactor (C-TPPB) operated with the tubing effluent recycle to enhance the biodegradation of toxic substrates in industrial wastewaters under severe loading conditions. Stepwise increasing influent concentrations (from 200 to 900 mg L^{-1}) of 2,4-dichlorophenol (2,4-DCP) were fed to a C-TPPB operated with Hytrel G3548 tubing to simulate phenolic wastewater. Practically complete 2,4-DCP removal has been achieved during the entire experimental period, but the increased load reduced biodegradation efficiency. At influent concentration of 700 mg L^{-1}, the first effluent recycle (recycle /influent flow rate ratio = 0.3) was applied: biodegradation efficiency doubled from 40 to 80% and was maintained until influent concentrations of 800 mg L^{-1}. Higher influent concentrations caused a decrease in 2,4-DCP biodegradation, so the effluent recycle ratio was increased to 0.5 at 900 mg L^{-1} and, also in this case, the bioreactor showed a fast recovery (~ 24 h) of the biodegradation efficiency at 80%. Mass transfer data analysis showed that the effluent recycle resulted in an increase of the mass transfer coefficient. This positive effect, joined with the reduction of the influent concentrations, demonstrated the feasibility of recycle application in enhancing the C-TPPB performance.

- **Keywords:** Industrial wastewater treatment; Continuous two-phase partitioning bioreactor (C-TPPB); Toxic organic compounds; Process optimization; Biological treatment

Shang-Hao Liu, Bin Zhang. *Using thermal analysis technology to assess the thermal stability of 1,3-dimethylimidazolium nitrate*. Pages 181-186.

1,3-Dimethylimidazolium nitrate ([Mmim]NO3), an ionic liquid, is a versatile and novel solvent for the petrochemical industry. Nevertheless, under high temperature conditions or thermal upset scenarios, [Mmim]NO3 can be decomposed in a manner that produces an explosion or other serious safety problems. The aim of this research was to investigate the thermal stability of [Mmim]NO3 by simultaneous thermogravimetric analyzer and high pressure differential scanning calorimetry. Isothermal experiments indicated that [Mmim]NO3 would be decomposed at a temperature substantially lower than the onset temperature. A pseudo-zero-order rate expression was applied to characterize the thermal decomposition kinetics of [Mmim]NO3, and related thermokinetic parameters were further obtained. Moreover, the temperature at which the thermal decomposition of ILs reached 10.0% for a given time of 10.0 h (T0.1/10h) was defined to assess the long-term thermal stability, which can be used as the maximum operating temperature of [Mmim]NO3. The results of this study may provide relevant processes for safer control based on the thermal hazard assessment of [Mmim]NO3.

- **Keywords:** 1,3-Dimethylimidazolium nitrate; Isothermal experiment; Onset temperature; Long-term stability; Maximum operating temperature

Senthil Muthu Kumar T, Krittirash Yorseng, Rajini N, Suchart Siengchin, Nadir Ayrilmis, Varada Rajulu A. *Mechanical and thermal properties of spent coffee bean filler/poly(3-hydroxybutyrate-co-3-hydroxyvalerate) biocomposites: Effect of recycling*. Pages 187-195.

Green composites were fabricated using poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) as the matrix and spent coffee bean powder (SCBP) as a filler by simple solution casting method. The effect of varying concentrations (5–25 wt.%) of SCBP on the thermal and mechanical properties was studied. The SCBP filler had better thermal properties than the matrix and the composites. There was slight increase in the glass transition temperature of the composites with higher concentration of the filler when compared to the PHBV matrix. The weight remaining at endset temperatures of the composites was found to be higher than for the matrix indicating enhanced thermal stability. The contact angle of the composites increased with increasing filler content changing from 75.8° to 97°. The tensile strength and modulus of the composite films reduced with increasing filler concentration but a reverse trend was observed in case of the % elongation at break. However, the tensile properties were comparable with other synthetic polymers such as LDPE, HDPE etc. Furthermore, the recycling of films did not significantly affect the mechanical and thermal properties. Hence, with comparable thermal and tensile properties, these biocomposite films can be considered for replacing the conventional synthetic non-biodegradable polymers such as polyethylene and polypropylene for packaging applications.

- **Keywords:** Municipal waste; Poly(3-hydroxybutyrate-co-3-hydroxyvalerate); Spent coffee bean powder; Thermal stability; Tensile strength

Qirong Wu, Min Gu, Yungui Du, Hanxiao Zeng. *Chemical composition and morphology of particles emitted from a wet flue gas desulfurization (WFGD) system*. Pages 196-203.

The chemical composition and morphology of particles emitted from a WFGD system were analyzed. The inlet particle diameter, inlet particle concentration and liquid/gas ratio (L/G), were all found to affect particle emissions. Smaller diameter particles and higher inlet particle concentrations resulted in increases Si and total particle mass concentrations. The elemental mass concentrations of the emitted particles were mainly

derived from inlet components, along with low levels of Ca, S, AL, Mg and other trace elements carried from slurry in the spray scrubber, with the Ca and S content of emitted particles predominantly being carried from the slurry. The particles emitted from WFGD were mainly fine particles, with up to 96% and 50% of particles being below 2.5μm and 1μm, respectively. Particles with a diameter below 0.5μm accounted for only 8.89%, 7.6% and 16.4% of particle emissions when the inlet particles sizes were 38.55μm 13.42μm and 6.16, respectively. The mean diameter of particles emitted from the WFGD system ranged between 0.6 and 1.2μm. These results confirm the particle removal ability of the WFGD system and improve our understanding of the chemical composition and morphology of particles emitted from WFGD systems, as well as their impact on the atmospheric environment.

- **Keywords:** WFGD; Particle removal; Chemical composition; Particle morphology

Swellam W. Sharshir, Youssef M. Ellakany, Almoataz M. Algazzar, Ammar H. Elsheikh, M.R. Elkadeem, Elbager M.A. Edreis, Abdelrahman S. Waly, Ravishankar Sathyamurthy, Hitesh Panchal, Mahmoud S. Elashry. *A mini review of techniques used to improve the tubular solar still performance for solar water desalination*. Pages 204-212.

Today, clean water availability is quite hard especially for people living in remote areas and coastal ones. Even for those who find underground water, they need to treat it before using. Solar still is a very useful method to be used in desalination and purifying water as it uses solar energy which is available around the globe with no cost and is eco-friendly. Many types of solar stills are invented to increase its daily productivity (stepped solar stills, inclined solar stills, pyramid solar still, wick, etc.). In this regard, this paper represents a mini-review of a new type of solar still named tubular solar still (TSS), its working method, thermal analysis, performance and method of enhancement. The remarkable improvement is attributed to the use of nanotechnology (ZnO nano-rod shape) by which the productivity and efficiency are increased by 30% and 38% respectively. Moreover, some futuristic developments on TSS are included in this review.

- **Keywords:** Solar desalination; Tubular solar still; Review; Productivity; Nanotechnology

Buzhuang Zhou, Shengqiang Yang, Chaojie Wang, Jiawen Cai, Qin Xu, Naiwen Sang. *Experimental study on the influence of coal oxidation on coal and gas outburst during invasion of magmatic rocks into coal seams*. Pages 213-222.

This research aims to explore the influence mechanism of coal oxidation on the outburst risk of coal seams after a magmatic rock invasion. Hence, the possibility of an outburst risk in coal seams caused by coal oxidation under different oxygen concentrations was evaluated by utilizing multiple indices to predict the outburst risk of coal and gas. By applying the BEL-MAX automatic analyzer for specific surface area (SSA), the change laws of the Brunauer–Emmett–Teller (BET) SSA and pore volume during coal oxidation were analyzed. Moreover, the change in multiple physical parameters during coal oxidation was measured by employing an industrial measurement instrument, gas chromatograph, initial velocity (△P) tester, and hardness tester. The results indicate that with the increasing oxidizing temperature of coal, the contents of moisture and volatiles in the coal declined constantly while the BET SSA and pore volume increased, thus strengthening the capability of coal mass for adsorbing gas. Moreover, the coal strength reduced with the constant development of pores, as shown by the Protodyakonov's coefficient (f value) of coal mass that decreased constantly and △P of gas diffusion for reflecting the diffusion capability of coal for the gas to increase gradually with increasing oxidizing temperature. With the increasing oxygen concentration in an oxidizing

atmosphere, the required oxidizing temperature at which the comprehensive index reflecting the outburst risk of coal mass was larger than the critical value reduced gradually. Thus, the coupling effect of magmatic rock invasion into coal mass, thermal metamorphism, and oxidation reaction led to the increase in gas content and SSA of coal mass, thus improving the capability of coal for adsorbing and storing gas. Correspondingly, the mechanical strength of coal mass reduced and the initial velocity of gas diffusion from coal mass increased significantly. Additionally, owing to the sealing effect of magmatic rock inhibiting the migration of gas in coal mass in the area, the risk level of coal and gas dynamic disasters in the area increased significantly.

- **Keywords:** Coal moisture; Coal strength; Low temperature oxidation; BET specific surface area; Outburst prediction index

Huawei Wang, Zijuan Lv, Yi Song, Ya-nan Wang, Daoyong Zhang, Yingjie Sun, Yiu Fai Tsang, Xiangliang Pan. *Adsorptive removal of Sb(III) from wastewater by environmentally-friendly biogenic manganese oxide (BMO) materials: Efficiency and mechanisms*. Pages 223-230.

Antimony(Sb(III)) contamination in wastewater has raised global concerns due to its high toxicity. The efficiency and mechanisms of Sb(III) adsorptive removal from wastewater with environmentally-friendly biogenic Mn oxide (BMO) materials as adsorbent were investigated, based on kinetic experiments and multispectroscopic analyses. Kinetic experiments showed that after 300 min of reaction, 97.79–100% of Sb(III) and 85.60–92.92% of total Sb were removed, indicating that BMO can quickly and effectively oxidize Sb(III) and sequester Sb(V) from water. The bacterial activity in BMO did not significantly affect Sb(III) removal, but a decrease in the release of Mn(II) into solution may provide new reactive sites for the re-oxidation of Sb(III). X-ray photoelectron spectrometer (XPS) high-resolution analysis suggested that Sb(V) was the only speciation remaining in the solid phase after the reaction of Sb(III) with BMO. X-ray diffraction (XRD) results further showed that the fast oxidation of Sb(III) by BMO led to the production of Mn(II) antimonate (Mn2Sb2O7) precipitates. Successive extraction experiments confirmed that residual fraction (67.49–83.62%) and Mn oxide bound fraction (13.18–29.72%) were the dominant fractions of Sb(III) after 300 min of reaction, which were relatively stable and had low leaching risks. These findings indicated that BMO performed well in removing Sb(III) from wastewater.

- **Keywords:** Antimony(III); Biogenic Mn oxides (BMO); Removal efficiency; Bacterial activity; Mn(II) antimonate; Mechanisms

Sumit H. Dhawane, Tarkeshwar Kumar, Gopinath Halder. *Insight into biodiesel synthesis using biocatalyst designed through lipase immobilization onto waste derived microporous carbonaceous support*. Pages 231-239.

The enzymatic conversion of vegetable oils is a cleaner alternative to the chemically catalysed transesterification processes. The present study describes the development of heterogeneous enzyme catalyst by immobilising lipase onto waste derived activated carbon (AC) support and its application in enzymatic transesterification. The study includes optimisation of enzymatic transesterification using indigenously prepared biocatalyst by considering four parameters. The main parameters affecting the biodiesel yield were recognized by statistical analysis using analysis of variance (ANOVA) and contribution factor. The obtained optimised conditions for maximum biodiesel yield were: catalyst loading 3 wt%, M/O ratio 6:1, time 5 h and temperature 20 °C. The ANOVA revealed that catalyst loading and temperature are the two most dominant parameters affecting the biodiesel yield significantly with contribution factor 68.99 and 27.95% respectively. The produced rubber seed oil methyl esters (RSOME) were characterised for

estimating fuel properties and found to be comparable with conventional diesel. The catalyst is reused at the optimised condition and observed that 6–7% decay in catalytic activity after 7 cycles. Thus, AC supported lipase as a biocatalyst is highly effective in conversion of rubber seed oil (RSO) to biodiesel at optimised conditions derived using Taguchi approach.

- **Keywords:** Alternative fuel; Biocatalysis; Biodiesel; Carbonaceous support; Immobilised lipase

Fares Almomani, Simon Judd, Rahul R. Bhosale, Mohammed Shurair, Khaled Aljaml, Majeda Khraisheh. *Intergraded wastewater treatment and carbon bio-fixation from flue gases using Spirulina platensis and mixed algal culture*. Pages 240-250.

In this work, Spirulina platensis (SP.PL) and mixed algal culture (M.X) were used as an economical treatment technology to solve dual environmental issues related to carbon dioxide (CO2) capturing and wastewater treatment. The impact of the concentration of CO2 (2.5%, 5%, 10%, and 15% v/v) on the specific growth rate (μ) of SP.PL and M.X, biomass production (Px), carbon dioxide bio-fixation rate (RCO2), organic matters and nutrient removals were assessed. The μ values of SP.PL and M.X increased by increasing the CO2 concentration until the optimum value (10v/v%) was reached, after that, increasing the CO2 dose negatively affected the growth rate. μ values ranged from 0.45–0.79 day−1 for SP. PL and from 0.48 to 0.86 day-1 for M.X. Both algae strains have shown high biomass productivities (Px of 0.246 gdw.L−1.d−1 for SP.PL and 0.384 gdw.L−1.d−1 for M.X), and significant carbon bio-fixation rates (RCO2 of 0.360 gC.L−1.d−1 for SP.PL and 0.460 gC.L−1.d−1 for M.M). the M.X obtained from the secondary basin of local WWTP performed better than single strain SP.PL in removing organic matter (% CODremoval ˜ 97.2), total inorganic nitrogen (% TINremoval ˜ 99.6) and total phosphorus (TPremoval˜ 99.41) under all studied conditions. Microalgae with fast growth rate and naturally grown in the water system can be a sustainable and effective technology for CO2 uptake and nutrients removals.

- **Keywords:** Bio-fixation; Greenhouse gases; Nutrient; Wastewater treatment; Climate change

Zari Fallah, Hossein Nasr Isfahani, Mahmood Tajbakhsh. *Cyclodextrin-triazole-titanium based nanocomposite: Preparation, characterization and adsorption behavior investigation*. Pages 251-265.

A cyclodextrin-triazole-titanium based nanocomposite (CD.COM) was prepared and its structure was characterized. The CD.COM exhibited a good adsorption performance for removal of Zn+2, Cd2+ and Pb2+ ions from aqueous solutions. The adsorption parameters were evaluated to find the optimal condition of pH = 7, contact time = 1 h, adsorbent dosage = 0.01 g and initial metal ion concentration = 20 mg L−1 at 25 °C. The Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherm models were investigated using adsorption equilibrium data. The Langmuir model showed best fitted with the experimental data, resulting in the maximum adsorption capacities of 147.1, 158.7 and 200.0 mg g−1 for Zn+2, Cd+2 and Pb+2 ions, respectively. Among the pseudo-first order, pseudo-second order, intraparticle diffusion and Elovich models, the kinetic data was well matched with the pseudo-second order model. Thermodynamic parameters indicated a spontaneous and endothermic adsorption process. By these results a plausible mechanism involving a monolayer chemical adsorption as the rate-determining step was suggested. The bioadsorbent showed high selectivity for Pb+2 ions in the presence of other coexisting metal ions. The CD.COM can be easily regenerated in HCl, HNO3 or EDTA solutions and reused for at least five cycles without significant loss of the adsorption capability.

- **Keywords:** TiO2; β-Cyclodextrin; Click reaction; Nanocomposite; Bioadsorbent

K. Rambabu, G. Bharath, P. Monash, S. Velu, Fawzi Banat, Mu. Naushad, G. Arthanareeswaran, Pau Loke Show. *Effective treatment of dye polluted wastewater using nanoporous CaCl2 modified polyethersulfone membrane*. Pages 266-278.

High molecular weight polyethersulfone (PES) nanoporous membranes modified with different loading of calcium chloride (0.5, 1, 2 and 3 wt.%) were prepared by dry-wet phase inversion method. Low molecular weight polyethylene glycol (PEG200) was used as pore constrictor and pore former for the blend membrane series. Fabricated membranes were characterized with various analytical and experimental techniques. Results showed that the CaCl2 blend PES/PEG200 membranes were nanoporous in nature with improved porosity and permeability. Addition of CaCl2 improved the mechanical stability and water permeability of the composite membranes. Performance of CaCl2 incorporated PES/PEG 200 membranes was investigated using selected dyes (congo red, orange II, crystal violet and methylene blue) and salts (Na2SO4 and MgSO4) separation from its aqueous solution. CaCl2 doped membrane showed better dye rejection behaviour with a permeate flux sequence as congo red < crystal violet < orange II < methylene blue. Size and charge based exclusions along with adsorption were identified as the separating principles. Fouling analysis clearly showed that CaCl2 incorporated membranes possessed better antifouling effect than membrane without CaCl2. Studies indicated that 1 wt.% CaCl2 loaded PES/PEG 200 membrane showed better performance than other fabricated CaCl2 blend membranes. Thus the CaCl2 blended PES/PEG200 membranes are promising for the treatment of dye polluted wastewater.

- **Keywords:** Membrane; Polyethersulfone; Calcium chloride; Dye separation; Wastewater

Tianshu Xu, Shili Chen, Shixu Guo, Xinjing Huang, Jian Li, Zhoumo Zeng. *A small leakage detection approach for oil pipeline using an inner spherical ball*. Pages 279-289.

Direct acoustic inspection with an inner detector has recently been suggested as an efficient leakage detection method. Because of its high sensitivity, this method is very promising for pipeline health monitoring. However, few studies have used automatic recognition based on the acoustic signature of leakage signals for direct acoustic inspection. In this study, a hybrid computational fluid dynamics and computational aeroacoustics mathematical model of small leakage based on Lighthill's analogy was constructed to simulate the acoustic signature in the vicinity of a leakage source. The obtained results show that the leakage sound is a broadband signal with dispersion characteristics. Furthermore, because of the appearance of a stationary wave, amplitude peaks emerge at specific frequencies in the sound pressure spectrum. According to the simulation parameters, a specific experimental environment was constructed that matched the simulation results. Inspired by the formant recognition method used in automatic speech recognition, a novel acoustic signature extraction approach was proposed based on Mel-frequency cepstral coefficients. Moreover, instead of a full band, a redesigned frequency band was applied in response to the influence of noise interference and the sound pressure spectrum. An efficient support vector machine classifier was employed to solve the binary classification problem (regardless of leakage), and the obtained results are very encouraging: an almost 10% performance improvement was achieved with a redesigned frequency band, and both the accuracy and specificity of the recognition system reached up to 97%.

- **Keywords:** Small leakage detection; Sound pressure spectrum; Characteristic frequency band; MFCCs; SVM classifier

Yihuan Wang, Peng Zhang, Guojin Qin. *Non-probabilistic time-dependent reliability analysis for suspended pipeline with corrosion defects based on interval model*. Pages 290-298.

When a suspended pipeline has corrosion defects, its failure is due to the combination of being suspended and corrosion. Compared with the probability reliability method, the non-probabilistic interval model that considers the factors to be independent only needs a small amount of data to obtain the variation bounds, and it is more economical for reliability analysis. Given that time-dependent reliability analysis based on a random process requires a large amount of data, an interval model for the suspended pipeline with corrosion defects based on the convex model method is proposed. First, based on the extreme suspended length's formula of pipeline through numerical simulation, this paper proposes a model that combines the time-accumulation effects of resistance and corrosion growth with time. Second, the time-dependent limit state equation is established considering the corrosion-defective suspended pipeline for the assessment of practical pipeline engineering. Finally, the non-probabilistic time-dependent reliability model is put forward for the decay characteristics of the resistance under the influence of multi-factors, which can be used as the effective complement of time-dependent reliability analysis based on random process theory. By combining numerical examples, the effectiveness of the present method is demonstrated. Thus, this paper provides a theoretical basis for the maintenance of buried oil and gas pipelines as well as the integrity management of pipelines. More importantly, an assessment standard for a suspended pipeline with corrosion defects is established that can work with poor information. It is of considerable significance for the safe operation of pipelines.

- **Keywords:** Interval model; Corrosion defects; Suspended pipeline; Non-probabilistic time-dependent reliability; Numerical simulation

Ridham Dhawan, Brij Mohan Singh Bisht, Rajeev Kumar, Saroj Kumari, S.K. Dhawan. *Recycling of plastic waste into tiles with reduced flammability and improved tensile strength*. Pages 299-307.

This paper is focused on finding effective alternative for disposal of waste plastic bags by designing tiles with better mechanical strength, reduced flammability level, resistant against strong acids and bases and organic solvents, so that tiles can be used for designing structures for paver tiles for societal usage. In recent years the plastic consumption has increased manifolds leading to accumulation of plastic waste in large amount. Waste plastic bags being non-biodegradable and its extreme durability make its disposal process difficult. Plastic solid waste (PSW) present challenges and opportunities to the societies regardless of their technological advances and sustainability awareness. Traditional technologies for waste plastic disposal have failed to cope up with the increased generation of plastic waste. Also, the disposal of fly ash, waste by-product generated by combustion of coal in thermal power plants, is a serious problem both in terms of land use and environmental pollution. In this study, waste plastic matrix reinforced with fly ash (FA) and a flame retardant at different loadings (wt %) 5, 10, 15, 20 using twin screw extruder were molded into composite tiles and their characteristics were evaluated. Effect of different filler loading on waste plastic matrix was investigated. Composite (LFTP3) having appropriate ratios of fly ash and flame retardant showed reduced flammability with linear burning rate of 4.36 mm/minute and improved tensile strength of 9.68 MPa. Morphological and structural properties of all the composites were also investigated along with their flammability, resistance to different acids and bases and organic solvents, water absorption and mechanical strength.

- **Keywords:** Waste plastic; Fly ash; Triphenyl phosphate; Tiles; Thermal stability and tensile strength

Mohammad Zaid Kamil, Mohammed Taleb-Berrouane, Faisal Khan, Salim Ahmed. *Dynamic domino effect risk assessment using Petri-nets*. Pages 308-316.

The domino effect accidents in process industries pose a severe threat to human life and the environment and have the potential to affect nearby facilities as well. Numerous techniques, such as the Bayesian network, have been used for modelling the domino effect. However, these techniques have inherent limitations. These include the inability to consider complex behaviour of process equipment in combined loading and the time dependency of equipment failure. In the current study, a Generalised Stochastic Petri-net model, called as DOMINO-GSPN, is developed to model domino effect accident likelihood and its propagation pattern. The proposed technique is capable of modelling time-dependent failure behaviour of the process component in combined loading. The results from the model are useful in monitoring process risk. A case study is used to demonstrate the application and effectiveness of the model. The results from the model are compared with the past study of a Bayesian network-based domino effect model. This comparative analysis highlights the unique feature of the model and its relevance as a domino effect risk assessment and management tool.

- **Keywords:** Domino effect; Stochastic Petri nets; Risk analysis; Hazardous materials; Process safety

Bowen Liu, Nengwu Zhu, Yao Li, Pingxiao Wu, Zhi Dang, Yixin Ke. *Efficient recovery of rare earth elements from discarded NdFeB magnets*. Pages 317-325.

Discarded NdFeB magnets are becoming the focus of recycling rare earth metals since the content can reach as high as about 30%. In this study, a novel carbonization/hydrogenation-hydrolysis process was proposed for the recovery of rare earth elements (REEs) from discarded NdFeB magnets by using biochar derived from waste sawdust as an extracting agent. Results showed that NdFeB magnets could react with biochar to form NdFeB-C/H alloy in the carbonization/hydrogenation process. Three factors including material placement mode, temperature and NdFeB powder layer thickness affected the C/H saturation of formed NdFeB-C/H alloy in this process. When NdFeB powder layer with thickness of 1mm was placed above biochar layer (Mode-3) and carbonized/hydrogenated for 90 min at 1400 °C, the C/H saturated NdFeB-C/H alloy subsequently generated 99.43% of rare earth hydroxides purity and 88.4% of the REEs recovery efficiency after hydrolysis and magnetic separation process. All findings indicated that the new carbonization/hydrogenation-hydrolysis process using biochar as an extractant could be an efficient approach for recovering REEs from discarded NdFeB magnets.

- **Keywords:** Rare earth elements; Discarded NdFeB magnets; Biochar; Carbonization; Hydrogenation

Mengli Chen, Yimei Huang, Huijuan Liu, Shuwen Xie, Fakher Abbas. *Impact of different nitrogen source on the compost quality and greenhouse gas emissions during composting of garden waste*. Pages 326-335.

To overcome the problems of difficult degradation of garden waste and long composting period, some conditioner is often added in the composting process. However, different conditioner has different effects on the material transformation and composting quality in composting. In order to explore the influence of different nitrogen source material on the greenhouse gas and compost quality in the composting of garden waste, taking garden waste as compost material and adding soil as control, we respectively added chicken

manure, pig manure and sheep manure as nitrogen source conditioner, and conducted a 48-day composting experiment in a forced 45-l ventilation compost reactor. The results showed that composting with livestock manure reduced nitrogen loss and facilitated organic matter humification. Specially, compared to the control treatment of garden waste add soil (CK), the addition of chicken manure promoted the conversion of total organic carbon (TOC) to humic substances (HS), as well as reduced nitrous oxide (N2O) emissions during garden waste composting. Based on a redundancy analysis, NH4+-N, organic nitrogen (OrgN), total nitrogen (TN) and HS directly affected CH4 emissions, while N2O emissions were directly influenced by dissolved organic carbon (DOC), TOC and NO3−-N during garden waste composting. Based on a factor analysis, the compost quality was chicken manure(CM) > sheep manure(SM) > pig manure(PM). These results suggested that garden waste composting with the addition of chicken manure improved the effectiveness compost product, produced a mature and zero-side effect compost and reduced nitrogen losses.

- **Keywords:** Garden waste; Livestock manure; Greenhouse gas; Composting quality; Redundancy analysis

Guangli Guo, Huaizhan Li, Jianfeng Zha. *An approach to protect cultivated land from subsidence and mitigate contamination from colliery gangue heaps*. Pages 336-344.

In this study a technical approach was proposed to protect the cultivated land from subsidence and mitigate contamination from colliery gangue heaps on the basis of analyzing the influence mechanism of mining subsidence on cultivated land. The model to assess the capacity for protection of cultivated land was established and applied to Wugou coal mine, China. The results indicated the following: 1) Gangue backfilling mining technology can not only protect cultivated land, but also avoid wastage of surface land resources and eliminate pollution caused by the accumulation of gangue. 2) The protection of arable land by direct backfilling of gangue was 25 ha/Mt and that by implementing underground treatment to avoid loss of surface land by occupation of gangue was 5.087 ha/Mt. The four provinces in China that face these two serious problems were taken as examples to analyze prospects for the promotion and application of this technology. This theoretical and applied research can provide a new technical approach for the protection of cultivated land and mitigating gangue contamination.

- **Keywords:** Cultivated land protection; Gangue pollution; Gangue backfilling; Capacity assessment; Coal mining

Ebrahim Allahkarami, Bahram Rezai. Removal of cerium from different aqueous solutions using different adsorbents: A review. Pages 345-362.

Given their unique physicochemical properties, cerium compounds are widely used in different industries. The increase in the consumption of these compounds has released more cerium to the environment. Considering the relative toxicity of cerium toward living organisms, it is important to treat cerium containing waste streams. Adsorption can be effectively employed for the treatment of cerium-containing waste streams. No previous review is available about the performance of the adsorption technique for the uptake of cerium from different aqueous solutions. Therefore, the authors presented extensive literature information about the potentially effective sorbents for the removal of cerium. This review article compiles a complete list of potentially effective sorbents in the removal of cerium. In this context, the efficiency of different adsorbents under different physicochemical parameters such as solution acidity, initial concentration, adsorbent type (available and developed sorbents), and dosage of cerium, contact time, temperature, and presence of competing ions in the solution was investigated, as well. To evaluate the performance of different adsorbents, their adsorption capacity for cerium ion and the overall cerium removal were studied. The application of different adsorption isotherm

models and kinetic models for cerium removal was also reviewed here. Finally, this review article identifies future research works and challenges on the adsorption of cerium by different adsorbents.

- **Keywords:** Adsorption; Cerium; Equilibrium studies; Kinetics; Process parameters